among a certain class of biologists, and, in consequence, has delayed progress in biology for a considerable time. Weismann alone is responsible for the discredit into which the Lamarck-Darwinian view of the causes of variation has fallen: the latter has become unfashionable and "not up to date." Thus biologists were and are to a certain extent afraid of looking at evolutionary questions under the assumption that the "inheritance of acquired characters" might possibly be correct, and failed to do, what was most needed, to prove or disprove this view by the way of experiment. Fortunately, at the present time, conditions seem to improve: observations and experiments are being made which have a distinct bearing upon this question, and we may say that unexpected results are forthcoming which tend to show that the Lamarckian principle, which is also Darwin's view of the origin of transmissible variations, should be reckoned with. We only hope that this spirit of emancipation from a scientific dogma may prosper and flourish, and true progress will be assured.

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NOTE ON THE MARKING SYSTEM IN THE ASTRONOMICAL COURSE AT COLUMBIA COLLEGE, 1909–10

AFTER the first half year's work in the introductory astronomical course at Columbia had been finished, a test was made to ascertain the precision with which marks were assigned after the mid-year written examination. The answer books as handed in by the students were arranged in alphabetical order and each fifth book selected. In this way eleven answer books were obtained, representative of the class as a whole and chosen entirely without bias.

These eleven books were then marked by the following six professors of astronomy: Professor John M. Poor, of Dartmouth; Professor F. R. Moulton, of Chicago; Professor Wm. Beebe, of Yale; Professor O. M. Leland, of Cornell; Professor S. A. Mitchell, of Columbia; Professor Harold Jacoby, of Columbia.

No professor was permitted to see the marks assigned by the others; all were instructed to let the mark 10 represent that degree of proficiency which may be expected reasonably from a competent student who works hard; and 6 was to be considered a pass mark. No attention was to be paid to neatness, spelling, etc.; the marks were to be assigned upon astronomical proficiency only. The following table contains the results, the names of the professors being replaced by letters of the alphabet so as not to make public which professors gave the highest or the lowest marks.

Book No.	A	B	C	D	E	F
1	9	9.0	8.5	7.2	9	7.3
2	7	6.6	7.0	5.9	6	6.5
3	9	9.0	8.8	7.2	8	8.0
4	10	9.4	9.9	8.0	10	9.2
5	7	6.2	6.7	5.8	7	5.9
6	10	9.8	9.6	7.6	10	9.5
7	6	5.8	6.3	4.6	7	5.4
8	9	9.3	9.7	8.0	9	8.8
9	8	5.7	9.0	6.7	10	8.7
10	10	8.5	9.1	6.2	9	9.0
11	9	9.0	9.5	6.1	8	9.0
Average	8.5	8.3	8.6	6.7	8.5	7.9

The professor in the column D, whose average mark is 6.7, appears to have taken 5 instead of 6 as his pass mark; he explained in a letter that only one of the students should fail to pass in his opinion, although he assigned three marks under 6.

Making due allowance for this circumstance in the case of professor D, there is a very close accord in the marks given by the various professors. It would appear that the students have attained a very high average in their work, and that the marking system is more precise than some of its critics would have us believe. Possibly this may be due to the fact that astronomy is an exact science.

For the information of other teachers, the examination paper is appended.

HAROLD JACOBY

COLUMBIA UNIVERSITY,
April, 1910

COLUMBIA COLLEGE
MID-YEAR EXAMINATION, FEBRUARY 3, 1910
Astronomy 1

Answer three questions only in each numbered group

1, *a*. Define: celestial sphere, declination, hour-angle.
1, *b*. Describe the ecliptic circle and explain why we always see the sun in that circle.
1, *c*. What visible phenomena are produced by the earth's axial rotation?
1, *d*. Prove that the altitude of the celestial pole is everywhere equal to the latitude.
2, *a*. Explain sidereal and solar time.
2, *b*. Why does the vernal equinox occur on or about March 21?
2, *c*. Explain the reason for time-differences between different places on the earth.
2, *d*. In an ordinary horizontal sundial, what is the angle of elevation of the gnomon, and why?
3, *a*. If a small round steel ball is dropped from a tower, will it reach the earth at a point directly under the point from which the ball was allowed to fall?
3, *b*. If not, where will it reach the earth, and why?
3, *c*. How is the length of the earth's radius determined?
3, *d*. What is the "torsional constant" and how is it determined for any given torsion balance?
4, *a*. Why is summer hotter than winter?
4, *b*. In the northern hemisphere, is summer longer or shorter than winter? Why?
4, *c*. Explain tropical and sidereal years.
4, *d*. Explain the supposed relation between the age of the Great Pyramid in Egypt and the precession of the equinoxes.
5, *a*. Explain the aberration of light.
5, *b*. What are the four constituent parts of a date?
5, *c*. What is the leap-year rule in the Gregorian calendar?
5, *d*. How does the apparent angular velocity of the moon on the sky compare with the sun's, and why?
6, *a*. How is the moon's distance from the earth ascertained.
6, *b*. Explain two lunar librations.
6, *c*. What are occultations, and how are they used to determine terrestrial longitudes?
6, *d*. Demonstrate Kepler's law of areas under the action of a central force.
7, *a*. Define sidereal period of a planet, Synodic period of a planet, Conjunction.
7, *b*. Derive formula for computing the sidereal period from the synodic period.
7, *c*. Explain the connection between the visibility of a planet and its synodic motion.
7, *d*. Why does the synodic period approach 365 days as a limit for the outermost planets of the solar system?

THE DEFINITION OF FORCE

TO THE EDITOR OF SCIENCE: Professor Henry Crew, in his presidential address before the American Physical Society,[1] comments unfavorably on the definition of force given by me in a letter in SCIENCE of December 24, 1909, viz., "Force is a pull or a push, something that causes or tends to cause either motion or a change in the velocity or direction of motion." He expresses a "fear" that this definition is used by "not a few students of physics."

An elaboration of the definition, given many years ago by Professor I. P. Church, is as follows:

> A force should always mean the pull, pressure, rub, attraction (or repulsion) of one body upon another, and always implies the existence of a simultaneous equal and opposite force exerted by that other body upon the first body, *i. e.*, the *reaction*. In no case should we call anything a force unless we can conceive of it as capable of measurement by a spring balance, and are able to say from what body it comes.

That "a few students of physics" use this definition ought not to be the cause of "fear" to any professor of physics; on the contrary, it should be a source of gratification. It is safe to say that nine tenths of all those students of physics who have occasion after their college days to make use of their physics are going to be either engineers or mechanics, and in that case they will have to learn this "standard definition of the engineer." It is well for them to learn it while they are young.

Professor Crew gives as "the one perfectly *correct, competent* and *complete* description of force" the "rate of change of momentum," and he credits Galileo and Newton with having thus defined it. I can not find, however, in the quotations he gives from Galileo and

[1] SCIENCE, April 8.